DEVICE

RELATED APPLICATION

[0001] This application is related to and claims priority from United Kingdom Application No. 0219243.3, filed August 17, 2002.

FIELD OF THE INVENTION

[0002] This invention relates to a valve cover device for immersion dry suits, and more particularly, but not exclusively, relates to a valve cover for escape survival suits worn by aircraft occupants, both fixed wing and helicopter.

BACKGROUND OF THE INVENTION

[0003] Immersion dry suits are employed as an aid to survival for aircraft occupants in the event of an aircraft ditching at sea. Such immersion suits are generally waterproof (often breathable) coveralls, with attached feet, waterproof entry zipper, and rubber seals at the neck and wrist. The immersion suit may be worn constantly or put on only in the event of an emergency. An immersion suit may provide some inherent insulation or may only provide a watertight barrier protecting the insulation of the clothing worn underneath.

[0004] On ditching, an aircraft occupant may be immersed in water and may also become inverted if the aircraft, particularly a helicopter, capsizes. In this event the aircraft occupant must overcome the effects of immersion and disorientation to exit the aircraft and survive.

[0005] The effects of sudden immersion in cold water are profound and significantly reduce the ability to hold one's breath. The wearing of an immersion dry suit by an escapee can significantly reduce the effects of this initial cold shock. However, the wearing of any immersion dry suit introduces the risk of additional buoyancy, as air is trapped within the immersion coverall. This is a particular problem for one-size-fits-all suits as they are big enough to be worn

dry suit introduces the risk of additional buoyancy, as air is trapped within the immersion coverall. This is a particular problem for one-size-fits-all suits as they are big enough to be worn by large people, which results in air trapped within the suit particularly when they are worn by small people. This buoyancy can prevent a successful escape from an immersed cabin with fatal consequences. Moreover, should the escapee become inverted in the water, trapped air may move to the leg or foot portions of the suit and it may not be possible for the escapee to right him/her-self due to the additional buoyancy in the legs.

[0006] The amount of additional buoyancy can be reduced by two methods of venting the immersion dry suit: either manual or automatic venting. The manual technique relies on the user employing a technique whereby they break and hold the neck seal of the immersion coverall open and away from the neck, squat down, and maintain this position whilst the air is vented through the neck seal, then close the neck seal before standing up. However, if the immersion coverall is ill fitting or the immersion coverall is put on quickly in an emergency abandonment situation and manual-venting method is not performed, then the problem of excess buoyancy may still persist.

[0007] This problem can be overcome by automatic venting by means of air exhaust valves incorporated in the immersion dry suit. These valves are designed to provide a means of venting the excess air when the dry suit is immersed. These valves can be located on both the shoulders and lower leg regions of the immersion suits. Should the user enter the water feet first, the hydrostatic pressure will normally cause the air to move up the suit and vent from the shoulder valves; conversely, should the escapee enter the water head first the air will normally move down the suit and vent through the valves in the lower leg regions.

[0008] The design of the air exhaust valves is commonly of a one-way design and features a rubber diaphragm that deforms on exposure to elevated internal air pressure. This elevated air pressure is the result of the hydrostatic pressure imparted by the water immersion forcing the trapped air into a reduced suit volume. The valves need to be very sensitive because the pressure

differential in shallow water is small. In theory, the diaphragm seals are closed when exposed to an elevated external pressure and should remain watertight.

[0009] However in practice, when such valves are exposed to water during escape from an aircraft, valve leakage can be experienced, particularly when the valves are located at the lower leg or ankle region of the immersion suit due, in part, to the escapee kicking in the water.

[0010] Such dynamic forces experienced during an emergency ditching and escape can cause the sensitive sealing diaphragm to flutter and break its seal, usually by the shearing effect of water passing across the face of the air-exhaust valve, causing some water ingress.

[0011] One potential corrective action could be to stiffen the diaphragm to resist exposure to such forces, but this action would have the effect of raising the valve's minimum operating pressure and reducing the valve's sensitivity. The result would be that the valve could only operate at higher internal pressures with the effect of leaving an amount of residual air within the immersion suit that would compromise underwater escape.

SUMMARY OF THE INVENTION

[0012] According to the present invention there is provided a cover for a valve of an immersion suit, the cover being adapted to deform from a first shape to a second shape on action of an external force, wherein when the cover adopts the second shape it substantially protects at least a portion of the valve from the external force.

[0013] Preferably, the cover comprises a base end and a head end connected to each other by at least one connecting portion. Preferably, the cover has a substantially tubular shape. Preferably, the base end is secured to the suit over or about the valve so that the valve is in fluid communication with a bore of the tubular cover.

[0014] Preferably, the connecting portion(s) extend away from the suit.

[0015] Preferably, the diameter of the base is greater than the diameter of the head. Preferably the tubular shape tapers inwardly as the tube extends from the base end to the head end, and more preferably, the cover is frusto-conical in shape.

[0016] Typically, the connecting portion(s) resist flow of fluid therethrough whereas the head end and base end substantially allow the flow of fluids therethrough. Nevertheless, the head may include a means to reduce the likelihood of snagging, such as a porous mesh screen.

[0017] Preferably the head end has a circular section edge. Typically the porous mesh screen is attached to the circular section edge. Preferably, the base end is of a hexagonal shape. Therefore, the cross section of the cover typically evolves from a hexagonal cross section at the base end, to a circular cross section at the head end.

[0018] Typically the valve is a diaphragm one-way air exhaust valve comprising at least one exhaust.

[0019] Preferably each/the connecting portion of the cover extend to a length greater than or equal to the distance between a point where each/the connecting portion is secured to the suit and the furthest exhaust from that point. Therefore when the cover deforms and adopts the second shape, the connecting portions are preferably large enough to substantially protect the exhaust(s).

[0020] Preferably, when the cover adopts the second shape, some air can escape through the exhausts.

[0021] The external force may be a dynamic force typically generated by fluid such as water moving with a shearing action with respect to the valve.

[0022] Preferably, the cover can deform from a first shape to a second shape on action of an external force from any direction.

[0023] Preferably, the cover is made from a plurality of conjoined segments. More preferably, there are three segments.

[0024] Preferably, the three segments are stitched together to form the conical cover. More preferably the three segments are sealed together using machine-applied hot-melt adhesive tape.

BRIEF DESCRIPTION OF THE FIGURES

[0025] An embodiment of the present invention will now be described by way of example only, in which:

[0026] Fig. 1 is a front view of a waterproof immersion suit;

[0027] Fig. 2 is a back view of the waterproof immersion suit showing a valve cover in accordance with the present invention;

[0028] Fig. 3a is a bottom view of a diaphragm one-way air exhaust valve;

[0029] Fig. 3b is a side view of the diaphragm one-way air exhaust valve;

[0030] Fig. 3c is a top view of the diaphragm one-way air exhaust valve

[0031] Fig. 4 is a plan view of the valve cover shown in Fig. 2;

[0032] Fig. 5 is a sectional side view of the valve cover of Fig. 2 and the valve;

[0033] Fig. 6 is an enlarged sectional view of circle B of Fig. 5 detailing attachment of a mesh screen to the valve cover of Fig. 2;

[0034] Fig. 7 is a side view of a flat pattern segment used to form the valve cover of Fig. 2.

DETAILED DESCRIPTION OF THE INVENTION

[0035] A waterproof immersion dry suit or garment is shown in Fig. 1 and comprises a one-piece suit 50 with attached waterproof socks 51. The suit 50 comprises a waterproof main entry zip 1, neck 2 and wrist 3 watertight seals and two shoulder diaphragm one-way air exhaust valves 4. The zip 1 extends diagonally down the front of the suit 50 from the right shoulder to left hip.

[0036] The suit 50 is typically made from a waterproof, breathable fabric such as Gortex™, or alternatively from any of a range of waterproof non-breathable fabrics. The suit 50 comprises a number of flat pattern pieces assembled using techniques appropriate to the material. This could be by adhesive only, or by the use of stitching and then the use of hot melt adhesive seam sealing tape. The seals 2, 3 are typically made from latex or neoprene.

[0037] A back view of the suit 50 is shown in Fig. 2. Valves 6 (not shown in Fig. 1) are provided on an outside ankle position 61 (as worn) of the suit 50. The valves 6 are typically diaphragm one-way air exhaust valves although any suitably sensitive one-way air valve may be used. The valves 6 are covered by a valve cover 5 in accordance with the present invention to protect them from the shearing effects encountered when immersed in water.

[0038] Referring now to Fig. 4, the valve cover 5 comprises three segments 31, 32, 33 which are constructed externally and about any existing, commercially available, one way air exhaust valve such as the valve 6; one example of such a valve 6 is made by Multifabs Survival Limited of Dyce, United Kingdom, under the product number MSL COMO 50(A) (casing) and MSL COMO 13A (diaphragm).

[0039] A segment 31 is shown in flat pattern in Fig. 7, the segments 32 and 33 are identical to the segment 31 and all are made from any lightweight waterproof fabric. The segment 31 has two bottom edges 34, 35 which are at an angle of 35-45° to each other, two side edges 36, 37 extending from the outer ends of the bottom edges 34, 35, and a top edge 38.

[0040] The side edges 36, 37 are first stitched then top stitched to side edges 37, 36 of the other segments 32, 33 along seam lines H-G and D-E to form a seam. The side edges 36, 37 of the segments 32, 33 are similarly stitched together to form a substantially conical body 25 with a hexagonal base 26. Each seam H-G, D-E is then sealed on the inner face of each segment 31-33 using machine-applied hot-melt adhesive seam sealing tape 19.

[0041] Top ends 39, 40 of side edges 36, 37 are shaped to form a cylindrical portion 16 at the top of the body 25 when the segments 31-33 are joined together. The top edges 38 of the conjoined segments 31-33 are then turned down and stitched closed at 22 to form a finished rim 27, as shown in Fig. 6. A mesh screen 8 is stitched 18 along the rim 27 to minimise the potential for the edge of the cylindrical rim 27 to snag during an escape. The length of the cylindrical portion 16 is preferably 5mm.

[0042] The bottom edges 34, 35 of the conjoined segments 31-33/body 25 are turned under to size and stitched. The body 25 is then presented to the suit 50, centred around the valve 6, and secured to the suit 50 by stitching 11. The bottom edges 34, 35 are then sealed with machine-applied seam sealing tape 13, as shown in Fig. 5.

[0043] In one embodiment of the valve cover 5, the bottom edges 34, 35 are each 70mm in length and form a hexagonal base 26 of diameter 120mm. The diameter of the hexagonal base 26 is such that it provides sufficient clearance for the machine-applied seam sealing tape 13 application without the valve 6 interfering therewith.

[0044] In one embodiment the diameter 21 of the cylindrical portion 16 is 30mm. The main body 25 of the cover 5 extends from the hexagonal base 26 to form a substantially conical shape over the valve 6.

[0045] The diameter 21 of the cylindrical portion is such that the surface area of holes in the mesh screen 8 allow at least an equivalent amount of air to pass therethrough compared with the amount of air which can be vented through air vents 15 of the valve 6. This ensures the valve cover 5 does not become inflated itself resulting in unwanted buoyancy.

[0046] The height of the cylindrical portion 16 is optimum such there is sufficient material to form an effective mating surface with the edge of the mesh screen 8 to facilitate stitching, yet maintain a low profile, again to minimise the potential for snagging.

[0047] Figs. 3a-3c illustrate a typical and conventional diaphragm one-way air exhaust valve 6 configuration, comprising an inner housing 45 and outer housing 46 into which a flat mushroom rubber diaphragm (not shown) is housed. Air outlet vents 15 are provided in the inner 45 and outer 46 housing to allow the escape of air from within the suit 50.

[0048] To manufacture the suit 50 with the valves 6, a circular aperture (not shown) of a diameter slightly less than that of the inner 45 and outer 46 housing is cut in the suit 50. The inner 45 and outer 46 housings with the diaphragm therebetween are held either side of the aperture so that they are concentric with each other and the aperture. Their edges are then plastic welded together and being of a greater diameter than the aperture, also hold a portion of the suit 50 therebetween.

[0049] The height of face 14 of the segments 31-33 is substantially equal to the height of face 17. The height of these faces 14, 17 is also substantially equal to the distance between any point on the stitching 11 and the furthest air vent 15 on the valve 6 from that point. For one

embodiment, the height of the faces 14, 17 is 80mm which is substantially equal to the distance between any point on the stitching 11 and the furthest air vent 15 from that point on the stitching 11.

[0050] Thus, in the event of a person wearing the immersion suit 50 entering water, the air pressure within the suit 50 will exceed the pressure outside the suit 50 and the diaphragm of the valve 6 will deform and allow the air to escape through the air vents 15 from within the suit 50 to outside the suit 50 thereby reducing the amount of trapped air within the suit 50 and the unwanted buoyancy in the suit 50. Should for any reason, the pressure be greater outside the suit 50, the diaphragm will not deform and no fluid will travel through the valve 6. Air may also escape through the shoulder valves 104.

[0051] The person moving their legs in the water will cause fluid to move across the valve cover 5, i.e. an external, dynamic force is applied to the cover 5. The cover 5 will deform under action of the dynamic force and cover and protect the air vents 15 of the valve 6 from the force. For example, if a dynamic force occurs in the direction of arrow 28 shown in Fig. 5, the face 17 of the cover 5 will deform and its upper end 17u will follow the path of broken line 29. The face 17 will thereby cover and protect the air vents 15.

[0052] Certain embodiments of the invention benefit from the vents 15 being protected in this way, without being completely sealed. Typically, a second dynamic force from another angle will quickly ensue due to the user moving their legs in a different direction and the cover 5 will deform at the angle of the second dynamic force again protecting the air vents 15 from the water rushing past the valve 6. Certain embodiments of the invention benefit from the fact that the cover 5 can deform at any angle in response to a dynamic force in order to protect the air vents 15 regardless of the angle of exposure to dynamic forces.

[0053] The covers 5 may also be positioned over the shoulder valves 104. However, the covers 5 are more useful over valves on the ankle portions 61 due to the additional shearing these valves

are exposed to when the person kicks his/her legs or swims while immersed. Other dynamic forces may also be exposed to the valve cover 5, for example, in the event of an underwater capsize wherein a flooded cabin (not shown) rotates underwater.

[0054] Certain embodiments of the invention allow the diaphragm to be set at a more sensitive level so that the maximum amount of air within the suit 50 may be expelled.

[0055] Certain embodiments of the invention protect the valve 6 without blocking the air vents 15, in contrast to a flat cover over the valve 6. Moreover, certain embodiments of the invention benefit from being flexible in contrast to a flat patch cover which may follow the curved profile of a user's leg and prevent the valve 6 from working.

[0056] The segments 31-33 can vary in shape so that the base 26 of the cover 5 is circular or polygonal. The more edges the base 26 has the more likely it is to deform accurately in response to a dynamic force. On the other hand, the more edges the base 26 has the more difficult it is to be stitched to the suit 50 and so a hexagonal base 26 is considered an optimum compromise.

[0057] Certain embodiments of the invention improve the performance of such a one-way air expulsion valve 6 such that it retains the sensitivity of a flexible diaphragm seal whilst eliminating the potential for water ingress when exposed to the dynamic forces associated with an underwater escape.

[0058] Other improvements and modifications may be incorporated without departing from the scope of the invention.